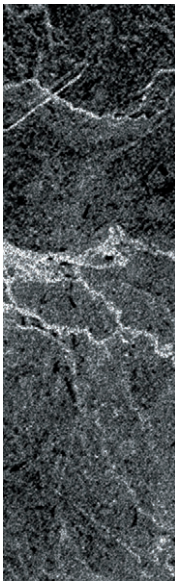

Critical Appraisal

POWER BLEACHING

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From anecdotal reports, many patients and some dentists believe that using a high-concentration whitening agent and an auxiliary light source (i.e., power bleaching) provides the best whitening service available. Some believe that the light provides additional whitening. Some believe that it provides a result that cannot otherwise be obtained. Others believe that it whitens far more quickly. The present review investigates the evidence available to support or refute these claims.

IN-OFFICE VITAL TOOTH BLEACHING—WHAT DO LIGHTS ADD?

D.K. Hein, B.J. Ploeger, J.K. Hartup, R.S. Wagstaff, T.M. Palmer, L.D. Hansen
Compendium of Continuing Education in Dentistry 2003 (24:340–52)

ABSTRACT

Objective: To investigate the "long-held empirical assumption that clinically tolerable levels of heat" accelerate the chemical breakdown of hydrogen peroxide (HP) and that leads, in turn, to faster whitening. Three commercially available in-office systems using HP and a light as an auxiliary heat source were investigated.

Materials and Methods: The overall study represents a series of five laboratory studies and one clinical study. The following are brief descriptions of the various studies:

1. The percentage of HP stated by the manufacturer was examined.
2. The spectral outputs of the lights were recorded and light intensity at the tooth surface was measured.
3. In vivo gel temperatures were measured. These measurements were made with and without the light. Additionally, measurements were performed with the light at each manufacturer's prescribed distance. Similarly, measurements were made at times consistent with the manufacturers' treatment guidelines.
4. Decomposition of the bleaching agents was measured with and without exposure to the light. Again, measurements were performed with the light at each manufacturer's prescribed distance and at times consistent with their treatment guidelines.
5. Decomposition of HP gels as a result of thermal energy was measured.

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6. Assessment of the clinical efficacy of the three materials was determined using the 3D-Master Shade Guide (Vident). Traditionally, studies have used shade guides to measure lightness only. The 3D system contains only five unique lightness groups, and the change in lightness from one grouping to the next is substantial. Accordingly, its use in measuring lightness would be limited. Instead, the authors used the shade guide to determine lightness, chroma, and hue. A split arch design was used. One side received application of the light, whereas the other did not. Previous split arch studies have simply compared left and right sides of the arch. These authors rejected that as not being valid or reliable. Rather than a comparison of right versus left side, the authors opted for comparing contralateral teeth (i.e., canine to canine, lateral to lateral, central to central). This created a by-tooth rather than a by-participant dataset.

The in-office whitening systems studied were LumaArch (LumaLite, Inc., Spring Valley, CA, USA), Opalescence Xtra Boost (Ultradent Products, Inc., South Jordan, UT, USA) and Zoom (Discus Dental, Culver City, CA, USA).

Results: For the purposes of this review, only the results of the five laboratory studies are reported. Results listed below follow the same numbering system used above in describing the testing procedures:

1. The products tested consistently contained a slightly higher percentage of HP than stated.
2. Light outputs were as follows:
   a. LumaLite: Spectrum was 405 to 580 nm; minor infrared output; intensity was 65 mW/cm^2.
   b. Optilux 500 light (Kerr Demetron, Orange, CA, USA; used Opalescence Xtra Boost): Spectrum was 440 to 528 nm; intensity was 128 mW/cm^2.
   c. Zoom! light: Spectrum was 362 to 587 nm; infrared spectrum was effectively filtered out; intensity was 72 mW/cm^2.
4. For all products, the average temperature of non-illuminated bleaching gel on the tooth surface was 31.7°C, or below body temperature. Temperatures with illumination were:
   a. LumaLite: 32.1°C, or 5°C below body temperature during its 7-minute exposure.
   b. Optilux 500 light (Opalescence Xtra Boost): 45.5°C, or 9°C above body temperature during its 30-second exposure.
   c. Zoom! light: 36.6°C, or roughly body temperature during its 20-minute exposure.
4. Decomposition rates were not significantly different for any of the three materials when comparing illuminated versus non-illuminated. There were, however, statistically significant different rates of decomposition between the three materials. LumaArch was significantly higher than Opalescence Xtra Boost and Zoom! and Zoom! was significantly higher than Opalescence Xtra Boost.
5. Deionized water and 35% aqueous HP liquid was used as a control. For the control, increasing the temperature up to 85°C resulted in only minimally accelerated breakdown of HP. All three products demonstrated faster breakdown than the controls. LumaArch and Zoom! were significantly more reactive than Opalescence Xtra Boost. Earlier findings indicate that the lights did little to increase temperature and decomposition of the gels. These data indicate that the chemistry of the bleaching gels was a more significant factor than the addition of heat to the control gel.

Conclusions: Testing indicated that temperatures well above those tolerated by teeth would be necessary

to speed the breakdown of HP to a clinically important level. Testing also indicated that the lights and the exposures used were not capable of generating the heat required. In fact, light in the infrared or heat-emitting spectrum was purposefully filtered out. The authors noted the presence of proprietary chemistry alternatively described as a catalyst, a booster, or an activator. They concluded that these compounds were significantly more important in increased reactivity than the heat provided by the lights. Further, they concluded that, for these three products, the lights did not react with these catalysts. Rather, the catalysts raised the pH, moving the gels from a stable acidic compound to one more basic. It is well known that HP is less stable at a more basic pH.

COMMENTARY

The clinical trial aspect of this overall study included color measurement approaches that were being used for the first time. It also included use of a by-tooth comparison. No citations or other evidence of the validity and reliability of these techniques were offered. As a result, the findings for this portion of the study were not shown, in my opinion, to be based on accepted research techniques. Accordingly, they are not included in this review.

In contrast, the laboratory testing aspects of this study provide very useful and appropriate data. The research questions being addressed were about how an auxiliary heat source might enhance the bleaching process. Historically, the explanation has been that, as with many chemicals, heating increases the reactivity of hydrogen peroxide. This study carefully investigated the following issues: First, given the spectral outputs, was it possible that these lights could break down pigments? Second, how much heat did these lights apply to the tooth surface and gel? This allowed comparison to estimates of the heat required. Third, was the rate of breakdown, or reactivity, affected by the lights? Finally, what surface temperature would be required to add substantively to the reactivity of HP? It is clear from these results that the lights are not capable of generating sufficient heat to accelerate whitening. Further, it was shown that the heat required to accelerate bleaching was beyond that which can be tolerated by teeth.

The authors do not make any pretense of predicting clinical performance from the laboratory tests. Rather, the tests focused on improving our understanding of the underlying chemical and biologic processes. As such, this use of laboratory testing was appropriate and informative. The authors' conclusion that it was the proprietary chemistry of the three products rather than the use of lights that was significant is a critical finding. Clinical studies comparing whiteners with no light to those with a light have generally shown that the light does not enhance whitening. The present study allows us to understand why this would be the case. Here, we see clinical and laboratory studies working synergistically. Clinical trials demonstrate that lights do not work and laboratory studies tell us light enhancement of whitening is contrary to the basic chemical and biologic processes at work.

In summary, these results provide strong evidence that any light intended to heat the gel will not be able to enhance whitening. Rather, the results indicated that acceleration of whitening came from proprietary chemistry. Given this very strong evidence, it is unlikely that any auxiliary heat source tolerable to the pulp will enhance whitening. Instead, chemical activation is the key to accelerating the whitening process. Accordingly, it would appear that future advancements in lights will probably result from development of a light that is keyed specifically to a highly effective catalyst.

CLINICAL EVALUATION OF IN-OFFICE AND AT-HOME BLEACHING TREATMENTS

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Operative Dentistry 2003 (28:114–21)

ABSTRACT

Objective: To evaluate color change, color relapse, and tooth and gingival sensitivity using two American Dental Association-accepted whitening agents, one in-office and one at-home system.

Materials and Methods: This study used a split-mouth design to investigate an at-home whitening system (Opalescence 10% CP, Ultradent Products, Inc.), and an in-office system (StarBrite 35% HP; Interdent, Inc., Los Angeles, CA, USA). Participants were randomly assigned to have one-half of the maxillary arch bleached at home using a custom-made half-arch tray and the other half bleached with an in-office procedure.

The at-home product was used nightly in the half-arch tray for 14 days. For the in-office procedure, a rubber dam was used to protect the soft tissues. The teeth designated to be bleached using the in-office technique were exposed, whereas the other half arch was covered by the rubber dam. Three 10-minute applications of the bleaching gel were applied at each appointment. Two bleaching appointments 1-week apart were completed.

Color evaluations were performed at baseline, and at 1 and 2 weeks during active bleaching. Participants also returned at 1, 4, and 10 weeks after the end of bleaching. Color was measured three ways: First, tooth color was matched using a shade guide (Trubyte Bioform; Dentsply International, York, PA, USA). Second, two calibrated, independent evaluators used clinical photographs to judge color difference between the right and left halves of the arch. Finally, a colorimeter (Minolta CR 321) was used. A positioning jig was used to assure consistent placement of the colorimeter from evaluation to evaluation.

Results: For all three color measures, the at-home bleaching method was associated with significantly more whitening. Differences between the two methods were significant at every evaluation period. Color relapse began immediately after the end of treatment and stabilized 4 weeks later. Accordingly, all the color comparisons reported here are for the 4-week post-bleaching evaluation. Mean ΔE for the two groups were 6.6 and 3.4, respectively, for the at-home and in-office treatments. Similarly, the shade guide data indicated a change of 13.8 and 9.4 tabs for the at-home and in-office systems. Finally, evaluators judged the at-home side of the arch to be lighter in 100% of cases.

Conclusions: Fourteen days of bleaching with tray-applied 10% carbamide peroxide resulted in significantly more whitening than two 3-minute applications of a 35% hydrogen peroxide agent.

COMMENTARY

Use of the split-mouth design allowed for side-by-side comparisons of the two products. This reassures the reader that the results are clearly clinically relevant. It is far more intuitive than ΔE calculations and less error-prone than shade tab matching. The downside of this design is that the difference between the two sides must be substantial to be observable to the eye. Recall that a color difference of more than 2.7 ΔE is required to exceed the threshold of acceptability. That equates to approximately a three-tab change using the Vita Classical shade guide, which is a substantial difference.

This is a clinical study so the results are clearly relevant to dental practice. As a randomized

clinical trial, the design is very strong. A basic tenet of evidence-based dentistry is that randomized clinical trials are better evidence than expert opinion or anecdotal reports. That means they are not as prone to possible misinterpretations of the data. In contrast, anecdotal observations are strongly influenced by emotions—that is, a few good or bad results that stand out in the observer's mind can have an undue influence on the opinion of the clinician. Rather than a few particularly good or bad cases, one wants to understand what happened on average. For all these reasons, this study provides more high quality evidence than has been previously available to practitioners. This article refutes anecdotal reports that in-office bleaching procedures with a high-concentration agent provide whitening that at-home procedures simply cannot achieve. Instead, it is clear that, compared to two 30-minute applications of 35% HP, 14 days of at-home whitening with a 10% CP provided superior whitening. Given the cost differential between these two approaches, this finding is of great importance to patients.

EFFICACY, SIDE-EFFECTS AND PATIENTS' ACCEPTANCE OF DIFFERENT BLEACHING TECHNIQUES (OTC, IN-OFFICE, AT-HOME)

T.M. Auschill, E. Hellwig, S. Schmidale, A. Sculean, N.B. Arweiler
Operative Dentistry 2005 (30:156–63)

Objective: To evaluate the three bleaching techniques in vivo.

Materials and Methods: Three products were tested: Crest Whitestrips (CWS) 5.3% hydrogen peroxide (Procter & Gamble, Egham, UK); Opalescence PF (Op10%) 10% carbamide peroxide (Ultradent Products, Inc.); Opalescence Xtra Boost (OpX) 38% hydrogen peroxide (Ultradent Products, Inc.). All three products were used according to manufacturers' instructions. CWS was worn twice daily for 30 minutes for a total application time of 1 hour per day. Op10% was worn 8 hours daily. OpX was applied for 15 minutes each day. The shade was matched by independent, calibrated examiners daily using the Vita Classical shade guide (Vident). The treatment was complete and color evaluations were stopped once the participant reached a shade change of six tabs. The final outcome of interest was the number of days of treatment each material required to achieve a six-tab change.

Tooth sensitivity, gingival sensitivity, and acceptance of the three techniques was assessed using visual analog scales. On the three scales, zero indicated either no discomfort or best acceptance. Severe discomfort and no acceptance were indicated by a score of 10.

Results: The mean number of treatments to affect a six tab change for CWS was 31.9. For Op10%, the mean was 7.2, and for OpX, it was 3.2. In terms of the number of days, for CWS, Op10%, and OpX, respectively, treatment took 16, 7, and 3 days. Total application times for the three products were 16, 56, and 0.75 hours for CWS, Op10%, and OpX, respectively.

On a scale of zero to 10, tooth sensitivity was 2.6, 3.4, and 2.9 for CWS, Op10%, and OpX, respectively. Gingival sensitivity for the three were 0.9, 0.4, and 0.2. There were no significant differences between the three products for either gingival or tooth sensi-

tivity. Acceptance of the three techniques was 2.3, 1.5, and 3.3 (lower numbers represent higher acceptance). The at-home treatment was significantly better accepted by participants than the in-office treatment.

Conclusions: The higher the concentration of the active ingredient, the faster the tooth lightening. Results for the in-office treatment could have been achieved in 1 day. There was a slight preference for at-home bleaching.

COMMENTARY

This study differed from others in that it investigated bleaching in terms of a defined result as opposed to a defined treatment period. This unique approach makes this a valuable study that confirms anecdotal reports that in-office bleaching is faster. Since the study's focus was on the time required to achieve a specific bleaching result, color measurements ended once a six-tab change had been achieved. As a result, this study's last measure of final color change was taken before color stabilization could occur. Accordingly, the amount of color rebound that may or may not have occurred for each of the three products is simply unknown.

The authors chose the number of days required to achieve a six-tab change as their primary outcome. This is compatible with the perspective of patients. OpX was able to achieve the final result in three applications. Using the protocol of the study, this amounted to 3 days. However, as the authors recognize, it would not be unusual to use three applications in one sitting. Accordingly, OpX could have achieved results in 1 day. In terms of days, Op10% was faster than CWS. In contrast, in terms of hours of application, CWS was faster than Op10%.

On many occasions, practitioners have related to me that their patients demand the fastest whitening possible. These participants had a different perspective. Op10% required the greatest application time but had the highest acceptance. Not only did this group not find 8 hours per night to be objectionable, they preferred it. The authors also noted that participants indicated that one reason for better acceptance of the at-home technique was that it required less chair time. Apparently, the participants in this study were mindful of their personal time investment in attending appointments. Participants considered the amount of time it took for application of the in-office gel and found this technique less acceptable than the at-home technique, despite the fact that they attended only three office visits, on average. As these participants were not charged for study related services, one can reasonably assume that the significantly higher cost of whitening using only an in-office procedure would make the in-office procedure even more unacceptable.

SUGGESTED READING

Matis BA, Cochran MA, Wang G, Eckert GJ. A clinical evaluation of two in-office bleaching regimens with and without tray bleaching. Oper Dent 2009;34:142–9.

Kugel G, Papathanasiou A, Williams AJ, et al. Clinical evaluation of chemical and light-activated tooth whitening systems. Compend Cont Educ Dent 2006;27:54–62.

Papathanasiou A, Kastali S, Perry RD, Kugel G. Clinical evaluation of a 35% hydrogen peroxide in-office whitening system. Compend Cont Educ Dent 2002;23:335–46.

Buchalla W, Attin T. External bleaching therapy with activation by heat, light or laser—a systematic review. Dent Mater 2007;23:586–96.

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THE BOTTOM LINE

- The theory that an auxiliary heat source increases the reactivity of HP, and thus enhances whitening, is not supported by laboratory or clinical evidence.
- The evidence clearly indicates that power bleaching does not provide superior whitening, and the light itself is not capable of whitening teeth. It is clear that in-office treatment with higher concentration agents results in a faster rate of whitening.
- In-office whitening systems that do not require light are available and demonstrate similar efficacy. The available evidence indicates chemical activation, rather than heat, increases efficacy. Accordingly, it would seem that future improvements will come from better catalysts and the expense of a light will continue to be unnecessary.
- We have a professional obligation to provide patients with an unbiased description of all reasonable alternative treatments. This review has the following implications:
  - Claims that power bleaching is superior and at-home bleaching cannot achieve the same result should be avoided.
  - Relative to a typical 2- to 3-week course of at-home bleaching, claims that power bleaching provides equivalent whitening in one visit should be avoided.
  - Claims that power bleaching provides an initial change more quickly are appropriate.

Editor's Note: We welcome readers' suggestions for topics and contributors to Critical Appraisal. Please address your suggestions to the section editor:

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